



HELIOBASE®

Standard Mode – Power Generation Calculation

Field Logic, Inc.

Version 1.0

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1. Introduction

About This Document (Tutorial)

HelioBase® is an application that predicts the generated output of the photovoltaic system (PV).

In this tutorial, the power is calculated by three different methods using the data generated in the "Standard Mode – Tutorial". Through the operations, the methods used to set the calculation parameters in the output power calculation methods are described.

◇NOTE◇

Data file used:

The following data file is used in this document.

- ① Tutorial-std.pvx

2. PV String output power calculation method types and outline

In *HelioBase®*, three types of calculation methods can be specified to calculate the PV string output power. Depending on the calculation method, parameters can be changed according to each method. The outline of each calculation method is described here.

[JIS C8907 parameter method]

This is the default calculation method.

The output power is calculated according to the power generation estimation method of the photo voltaic system specified by JIS C8907. Changing factor used to calculate the PV module temperature for each PV module placement method is allowed.

(The rated values are specified by JIS C8907.)

[Monthly temperature factor method (JPEA method)]

The PV module temperature can be calculated using the monthly temperature factor specified by JPEA and the output power can be calculated.

[PV module IV curve synthetic method]

The PV module output power can be calculated from the IV characteristics equation of the PV cell according to the meteorological conditions. Detail conditions can be set, for example, the method to calculate the PV module temperature can be set and various correction coefficients can be specified. Also, output operation points of the PV string, module, and cell string after calculation can be verified.

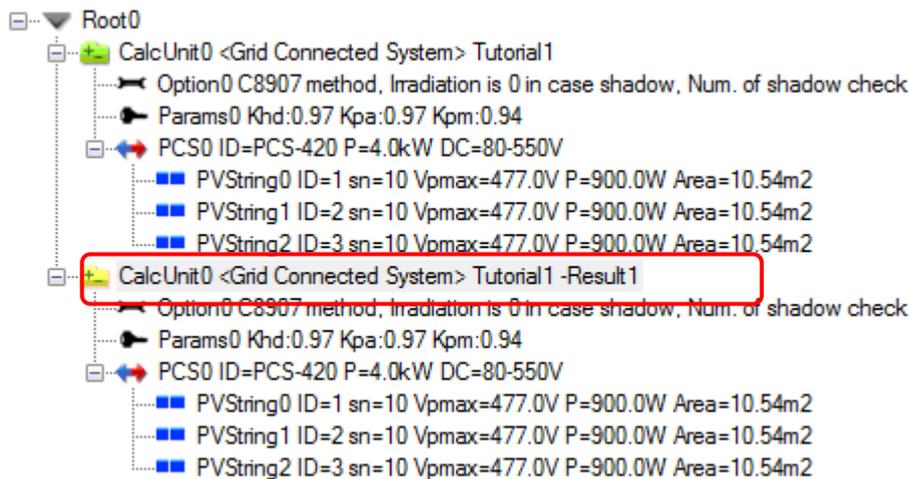
3. Preparation

Open the PVX file used in the "Standard Mode – Tutorial" and prepare for the simulation.

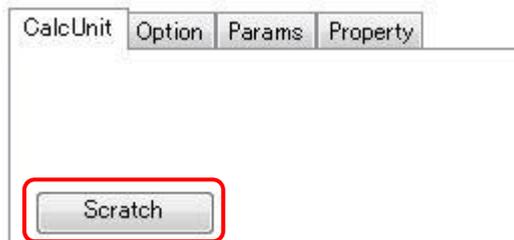
- ① Start *HelioBase*. From the menu, select [File] – [Open]. Open "Tutorial-std.pvx" in the dialog box displayed.
- ② Open [Specification tree] tab.



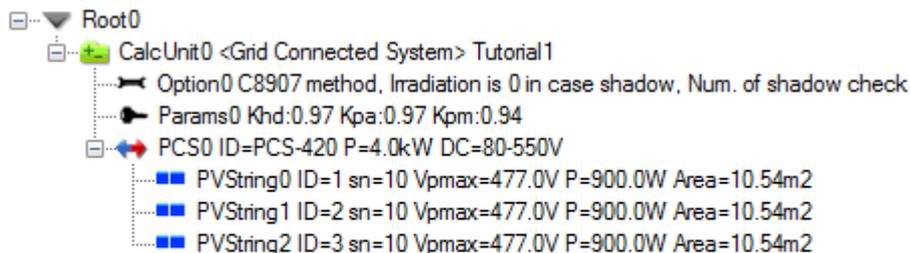
- ③ Select the calculation result node ([CalcUnit 0 <Grid Connected System>..... – Result 1]).



- ④ Click the [Scratch Results] button.



- ⑤ The previous calculation result is deleted. The following tree is shown.



Preparation is complete.

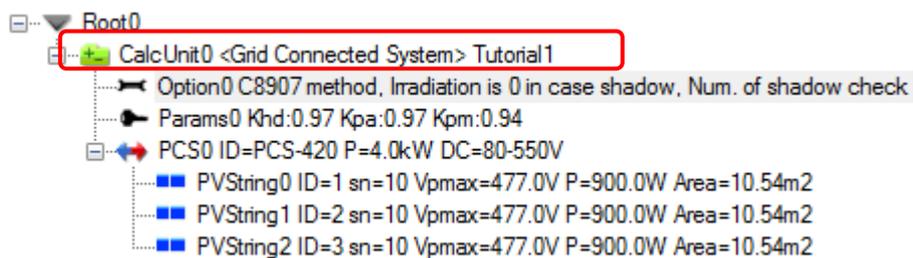
4. Simulation Using [JIS C8907 Parameter Method]

This chapter sets the calculation parameters using [JIS C8907 parameter method].

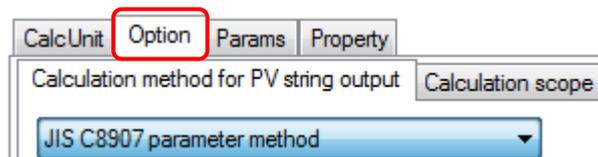
Select [JIS C8907 parameter method]

Select [JIS C8907 parameter method] (method to calculate the PV string output power)

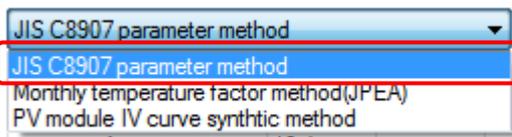
- ① In the tree, click [CalcUnit0] node.



- ② Open the [Option] tab at the bottom of the screen.



- ③ Select [JIS C8907 parameter method] in the [Calculation method for PV string] list box.



Set [Parameter C]

Set [Parameter C] (PV module temperature elevation factor) used for the calculation specified by JIS C8907. JIS C8907 specifies the default values. These values are used in this tutorial. To change the value, change the values shown below.

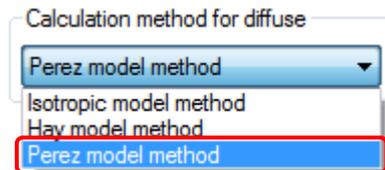
Parameter	
PV module install. type	C
Array mounter	<input type="text" value="18.4"/>
Roof top	<input type="text" value="21.5"/>
Roof panel with vent.	<input type="text" value="25.4"/>

◇NOTE◇

If the parameters are set in [Editing DB] – [Parameters depending on cell type], those parameters (values) are applied first.

Select [Method to calculate diffuse irradiation elements]

Select [Method to calculate diffuse irradiation elements]. In this tutorial, [Perez model method] (default) is selected.



◇NOTE◇

[Method to calculate diffuse irradiation elements] and calculation methods that can be selected
Specify the method to calculate the inclined surface diffuse irradiation elements for the PV placement plane.

The following three calculation methods can be selected:

[Isotropic model method]

Calculate the diffuse irradiation elements using the Isotropic model.

[Hay model method]

Calculate the diffuse irradiation elements using the Hay model.

[Perez model method]

Default. Calculate the diffuse irradiation elements using the Perez model.

After setting above, click the [Update] button. Go to Chapter 7.

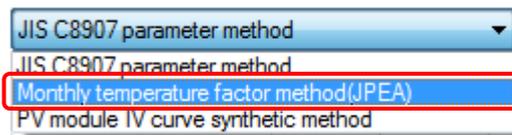
5. Simulation Using [Monthly Temperature Factor Method (JPEA Method)]

This chapter sets the calculation parameters using [Monthly temperature factor method (JPEA method)].

Select [Monthly temperature factor method (JPEA method)]

Select [Monthly temperature factor method (JPEA method)] (method to calculate the PV string output power).

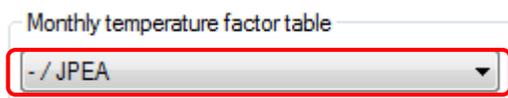
- ① In the tree, click [CalcUnit0] node.
- ② Open the [Option] tab at the bottom of the screen.
- ③ Select [Monthly temperature factor method (JPEA method)] in the [Calculation method for PV string output] list box.



Select [Monthly temperature factor table]

Select the table that specifies the monthly temperature factor.

The table (-/JPEA) specified by JPEA as the default has been selected. This tutorial uses this table (default).



Select [Calculation method for diffuse]

Select [Calculation method for diffuse]. In this tutorial, select [Perez model method] (default).

After setting above, click the [Update] button. Go to Chapter 7.

6. Simulation by Using [PV Module IV Curve Synthetic Method]

This chapter sets the calculation parameters using [PV module IC curve synthetic method].

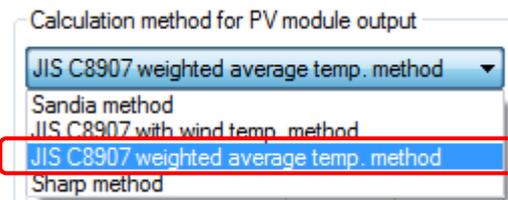
Select [PV module IV curve synthetic method]

Select [PV module IV curve synthetic method] (method to calculate the PV string output power).

- ① In the tree, click [CalcUnit0] node.
- ② Open the [Option] tab at the bottom of the screen.
- ③ Select [PV module IV curve synthetic method] in the [Calculation method for PV string output] list box.

Select [Calculation method for PV module output]

Select [Calculation method for PV module output]. In this tutorial, select [JIS C8907 weighted average temp. method].



◇NOTE◇

Calculation methods that can be selected in [Calculation method for PV module output]

The following three calculation methods can be selected:

[JIS C8907 weighted average temp. method]

Calculate the temperature by [JIS C8907 weighted average temp. method] specified by JIS C8907.

[Parameter C] (JIS C8907 weighted average temp. method) can be set.

[JIS C8907 with wind temp.method]

Calculate the temperature by [JIS C8907 wind temp. method] specified by JIS C8907.

[Parameters A, B] (JIS C8907 weighted average temp. method) can be set.

[Sandia method]

Calculate the temperature by [Sandia method].

[Parameters A, B, C, D] can be set.

Select [Calculation method for diffuse]

Select [Calculation method for diffuse]. In this tutorial, [Perez model method] is selected.

Select various correction tables

Select various correction tables. In this tutorial, select [-/-] (default) in all tables.

Low irradiance table

Spectrum characteristic tables

Incident angle depend. char. table

Diode IV curve table

Bypass

Blocking

◇NOTE◇

Various correction tables

Low irradiance table

Shows the ratio of the power generation contributing irradiation to the irradiation intensity.

Spectrum characteristic tables

Shows the effect of air mass to the irradiation intensity.

Incident angle depend char. table

Shows the effect of the incident angle of the light to the irradiation intensity.

Diode IV curve tables

Bypass

Shows the IV characteristics of the bypass diode.

Blocking

Shows the IV characteristics of the blocking diode.

To change the various correction tables, the data for each table must be entered in the [DB Edit] tab screen in advance.

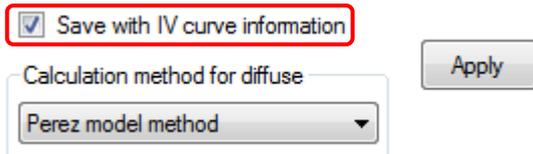
Record the effective IV curve data of the PV modules in the simulation result

The following data can be recorded in the simulation result:

- IV curve of each PV module
- Operating point

In this tutorial, the IV curve is recorded.

Place a checkmark in the [Save with IV curve Information] check box.



The image shows a software interface with a checkbox labeled "Save with IV curve information" which is checked. Below it is a dropdown menu labeled "Calculation method for diffuse" with "Perez model method" selected. To the right of these elements is a button labeled "Apply".

After setting above, click the [Apply] button. Go to Chapter 7.

7. Specify the Calculation Period

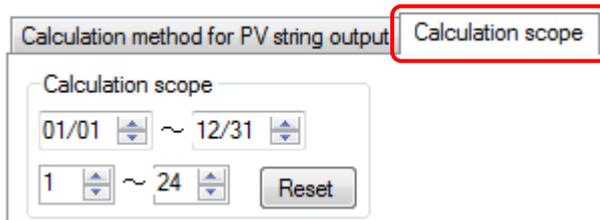
Specify the period of simulation.

In this tutorial, the simulation is done during the default period.

Default period: 01:00 – 24:00, 1/1 – 12/31

To change the period, do the following:

- ① Open the [Calculation scope] tab.



- ② Enter the simulation period in the [Calculation scope] box.
- ③ Click the [Apply] button.

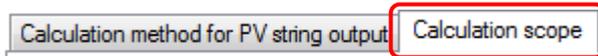
8. Specify the Calculation Method for Shading Effect

Set how the shade cast on the PV array affects the simulation.

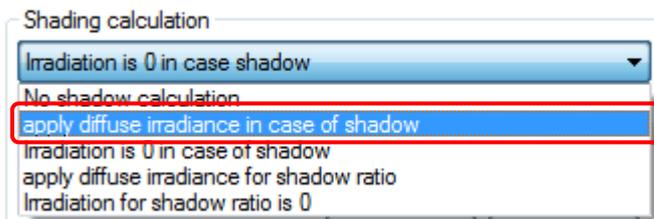
In this tutorial, only diffuse irradiation is used for the irradiation of the PV module in the simulation.

To change the setting, do the following:

- ① Open the [Calculation scope] tab.



- ② Select [Apply diffuse solar radiation if shaded] in the [Shadow Calculation] list box.



- ③ Click the [Update] button.

◇NOTE◇

Shading calculation types

There are 5 calculation methods that can be set in [Shadow Calculation] as follows:

[No shading calculation]

No shadow calculation

[Apply diffuse irradiance in case of shadow]

If shaded, only diffuse irradiation is applied to irradiation for calculation.

[Irradiation is 0 in case of shadow]

If shaded, set the irradiation to 0 for calculation.

[Shade ratio: apply diffuse irradiance for shadow ratio]

Set the shade ratio to diffuse solar radiation amount, otherwise to normal radiation amount for calculation.

[Shade ratio: Irradiation for shadow ration is 0]

Set the irradiation for the shade ratio is 0, otherwise to normal radiation amount for calculation.

Also, [JIS C8907 parameter method], [Monthly temperature factor method] and [PV module IV curve synthetic method] have different parameters because of different shade determination methods.

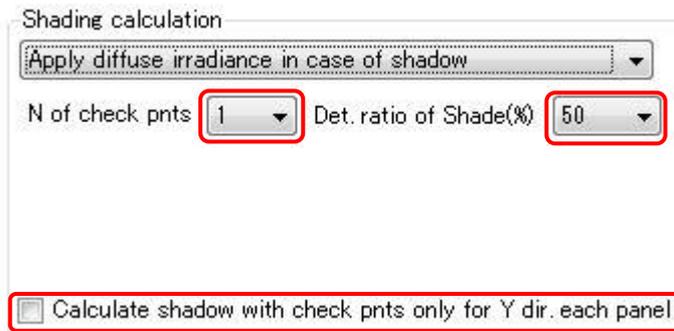
◇NOTE◇

Shade determination method in the power generation calculation method

Shade determination method in [JIS C8907 parameter method] and [Monthly temperature factor method]

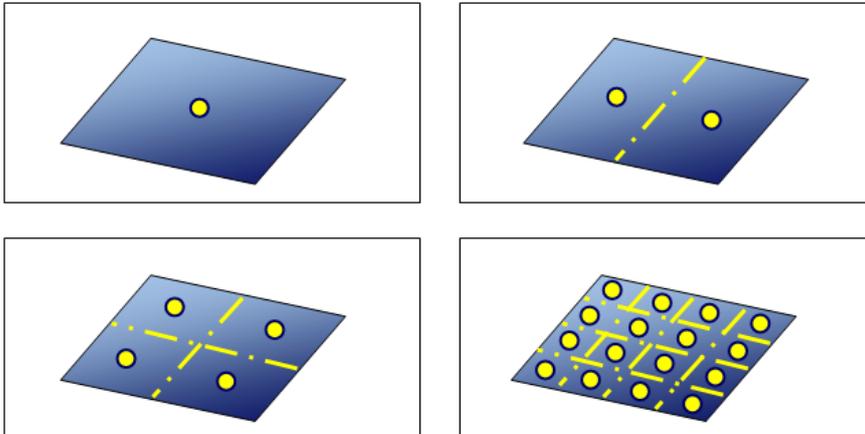
Above methods determine the shade for each PV module.

The following parameters can be set:



[N of shade check pnts] Set some check points in the PV module. Determine if any of the points are shaded. This parameter shows the number of check points.

Place the check points evenly in the PV module plane where the plane can be divided evenly vertically and horizontally and the points can be set in the center of the divided segments.



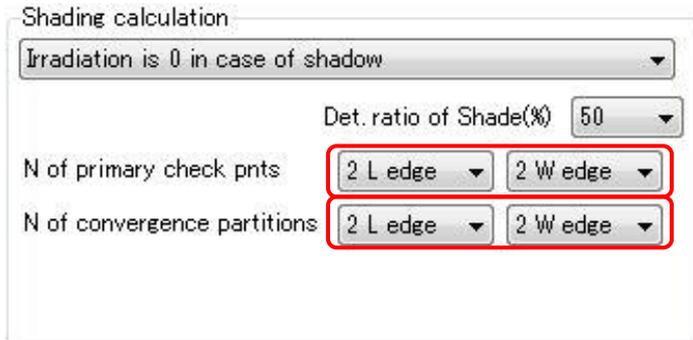
[Det. ration of shade %] Ratio of the shaded points.

[Calculate shadow with check pnts only for Y dir. each panel] Determine the shade ratio using only the check points in Y-direction in the PV module.

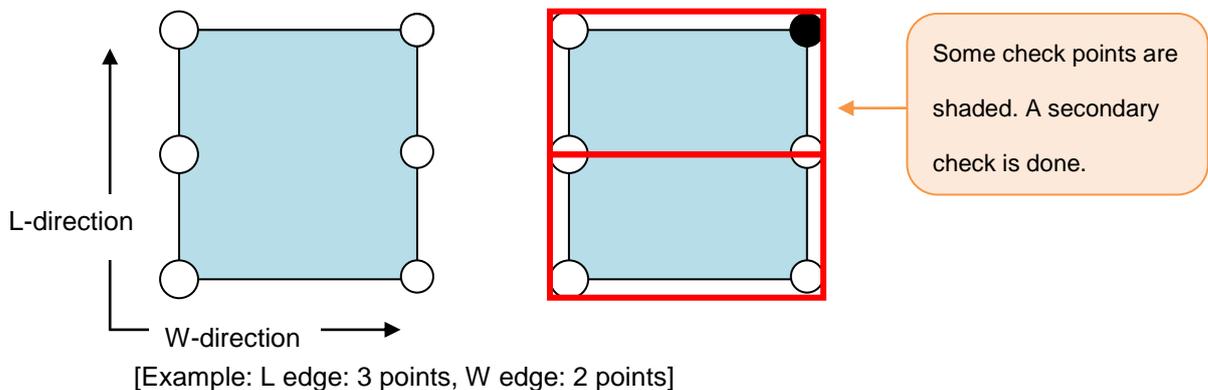
Shade determination method in [PV module IV curve synthetic method]

This method derives the cells that have the most shade effect in each cell string, and the shade ratio of the cell is set as the cell string shade ratio.

The following parameters can be set:



N of primary check pnts This method does multiple calculations to determine the shade. This parameter sets the number of division points in the L-direction and the W-direction used in the primary check. The primary check verifies whether each check point is shaded. If only some points are shaded, a secondary check is done. If all points are shaded, the check completes and the shade ratio in the region in the segment is defined as 100%.

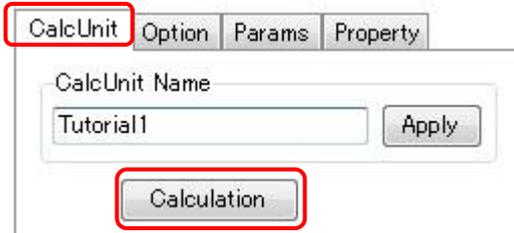


N of convergence partitions In the secondary calculation, the area is divided into 4 segments and the calculation is done recursively. The [Convergent divisions] specifies the number of cells (among check points) in which the recursive calculation converges. When the secondary calculation converges, the shade ratio of each cell is obtained. The value of the cell (in the PV cell string) that has the highest shade ratio is used as the shade ratio of the PV cell string.

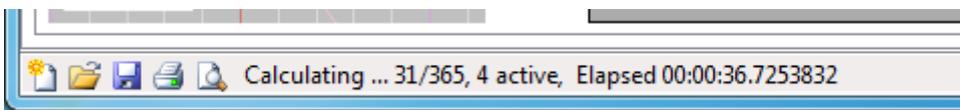
9. Simulation

After setting the calculation parameters (Chapters 3 – 8), start the simulation.

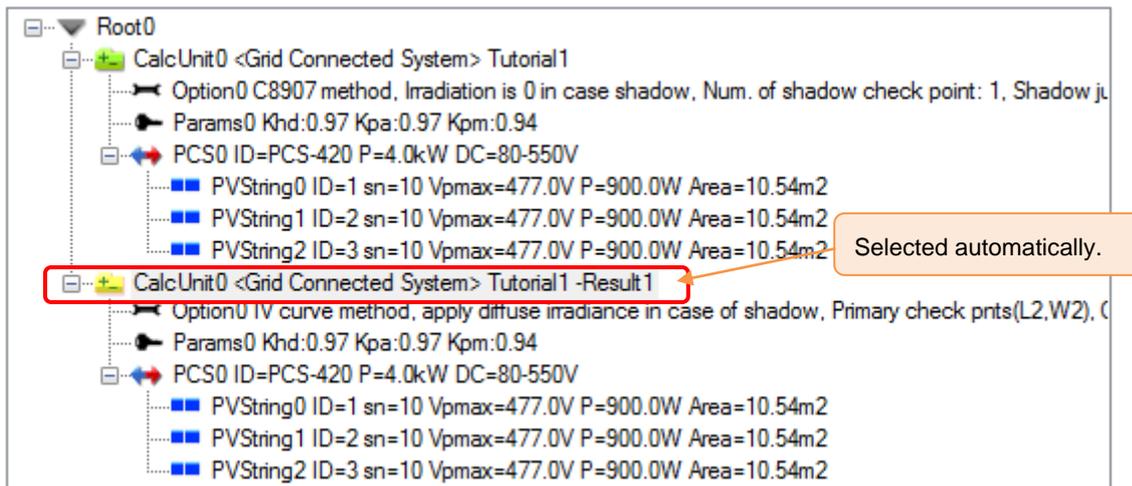
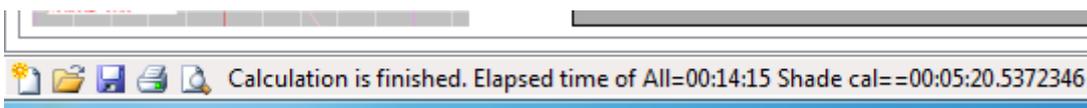
Open the [CalcUnit] tab. Click the [Calculation] button.



The calculation starts and the calculation status is shown in the status bar.

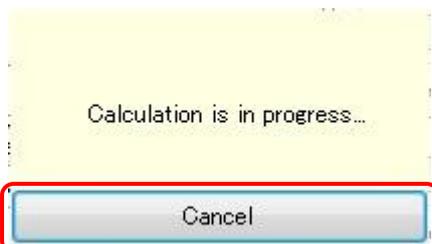


After the calculation, the status bar shows the following, and the calculation result node is automatically selected.



◇NOTE◇

During calculation, clicking the [Cancel calculation] button cancels the calculation.



10. Verify the Simulation Result

Verify the simulation result.

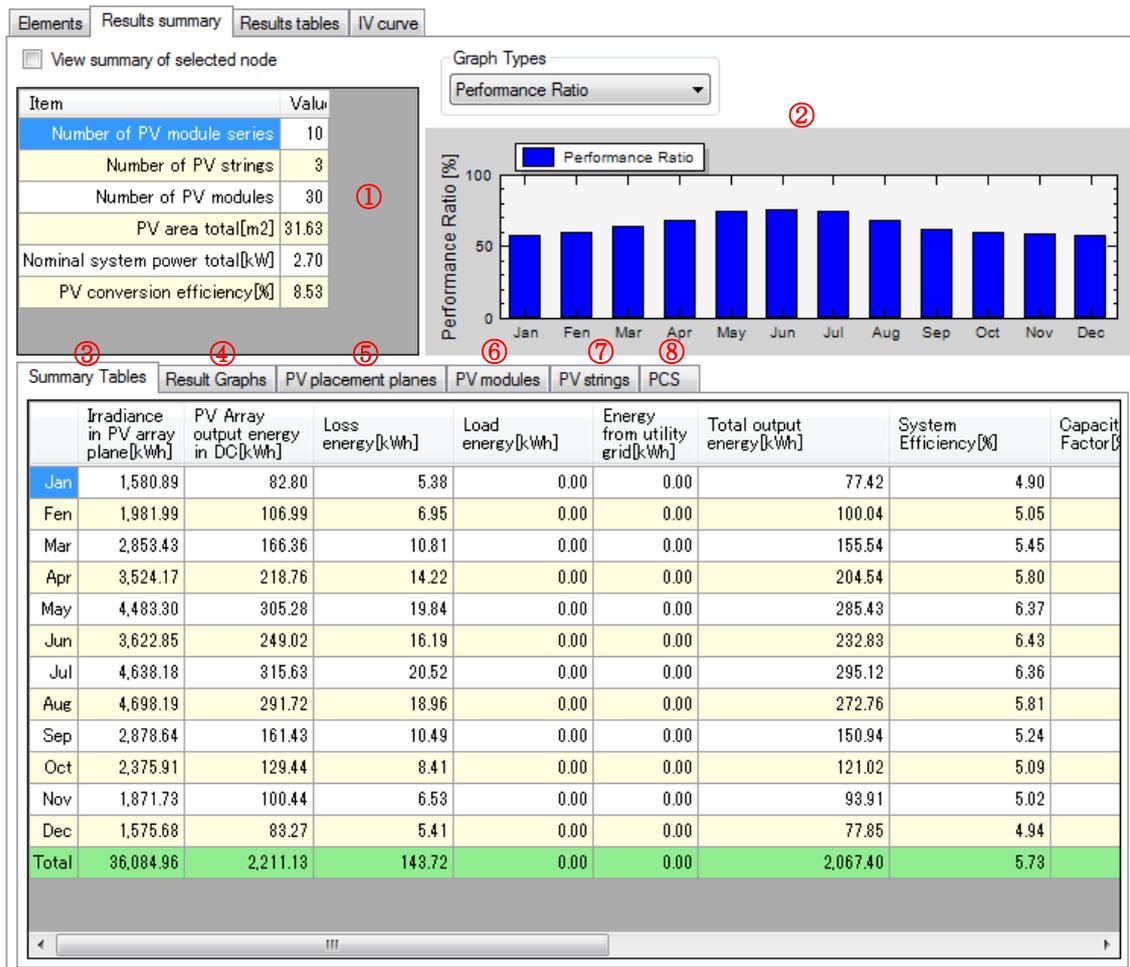
Verify the result summary.

Verify the result summary.

Click and select the [Calculation result] node, and open the [Results summary] (right side of the screen)



The following table is shown.



The following data in the tabs and graphs are shown:

- ①... Total number of PV modules used in the simulation and other data are shown.
- ②... The calculation result graph is shown. The following data are shown in the graph. The values correspond to the values in the [Summary tables].

[Irradiance in PV array plane] [kWh]:

Total radiation (monthly) of the PV array plane (according to the calculation time)

[PV Array output energy in DC] [kWh]

Total PV array output (monthly) (according to the calculation time).

[Loss energy] [kWh]:

Total loss energy (monthly) (according to the calculation time).

[Load energy [kWh]]:

Total load energy (monthly) of the power (PCS's no-load loss, phantom load, operation power consumption, etc.) that the PV system itself consumes and the power that the loading apparatus consumes)

Energy from utility grid [kWh]:

Total energy (monthly) that had to be received from the grid as the result of the calculation of the generated power and load power.

Total output energy [kWh]:

Total power in a month: The power value (loss power and load power are subtracted from the PV output power (according to the calculation time)) is accumulated.

If there is power from the utility grid, the calculation is done assuming that the total output power is 0.

[System Efficiency] [%]:

The value (%) where the total output power (monthly) is divided by the PV array plane radiation.

[Capacity factor] [%]:

The value (%) where the total output power (monthly) is divided by the total of the nominal maximum output of the PV array and the total time (month).

The nominal maximum output of the PV array is calculated as follows:

[Nominal maximum output of the PV module] x [Number of units]

[System Yield] [h/month]:

The value where the total output power (monthly) is divided by the nominal maximum output of the PV array.

This value shows how many hours are required for the system to generate the power equivalent for one month if the PV array runs continuously in the nominal maximum output state.

[System Yield] [h/day]:

Equivalent system operation time for one day. The value calculated as the equivalent system operation time monthly is divided by the number of days in each month.

This value shows how many hours are required for the system to generate the power equivalent for the power for one day if the PV array runs continuously in the nominal maximum output state.

[Reference Yield] [h/month]:

This value shows the time required to supply the PV plane irradiation (month) with the irradiation intensity of the standard state ($1.0\text{kW}/\text{m}^2$).

This value is calculated as PV plane irradiation divided by the PV array area.

[Performance Ratio] [%]:

The value (%) is calculated as the equivalent system operation time divided by the equivalent solar irradiation time.

This value is used as an index to describe PV system performance.

[Irradiance in PV array plane] [kWh/m^2]:

The value shows that the PV plane irradiation is divided by the PV array area.

③... [Summary Tables]

Shows a summary of the data for each month.

④... [Result Graphs]

The enlarged graph of graph ②. Two graphs can be shown for comparison.

⑤... [PV placement planes]

Shows the data for the PV module placement planes.

⑥... [PV modules]

Shows the data of the PV modules used in the simulation.

⑦...PV strings

Shows the data of the PV strings used in the simulation.

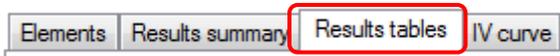
⑧... [PCS]

Shows the data of the PCS used in the simulation.

Verify the result table

Verify the result table.

Click and select the [Calculation result] node, and open the [Results tables] tab (right side of the screen).



The following table is shown.

The image shows the 'Results tables' tab in the software interface. A red box highlights the filter options, which include radio buttons for 'Mon/Day/Hour', 'Mon/Day', 'Mon', 'Month/Hour', and 'Year'. The 'Month/Hour' option is selected and marked with a circled '1'. To the right, there is a dropdown menu showing '02 2on' with a circled '2', and checkboxes for 'View details' (circled '3') and 'View selected node only' (circled '4'). Below the filters is a table with the following data:

Node	Month	Output Energy(kWh)	Input Energy(kWh)	Loss Energy(kWh)
CalcUnit0	1	57.01	57.01	0.00
PCS0	1	57.01	60.97	3.96
PVString0	1	20.94		3,519.60
PVString1	1	20.53		3,519.60
PVString2	1	19.50		3,519.60
CalcUnit0	2	76.39	76.39	0.00
PCS0	2	76.39	81.71	5.31
PVString0	2	28.07		3,270.70
PVString1	2	27.68		3,270.70
PVString2	2	25.96		3,270.70
CalcUnit0	3	122.66	122.66	0.00
PCS0	3	122.66	131.19	8.53
PVString0	3	45.81		6,940.70
PVString1	3	44.38		6,940.70
PVString2	3	40.99		6,940.70
CalcUnit0	4	184.50	184.50	0.00
PCS0	4	184.50	197.33	12.83
PVString0	4	78.15		10,864.50
PVString1	4	66.21		10,864.50
PVString2	4	52.97		10,864.50
CalcUnit0	5	280.14	280.14	0.00
PCS0	5	280.14	299.62	19.48
PVString0	5	102.00		14,872.10

The following describes the parameters:

①...[Type]

Select the time (unit) to select the result data.

②...[Month/Day/Hour]

Select (checkmark) a particular parameter (month, date, hour) to narrow down the data selected in ①.

③...[View details]

Show data other than power.

④...[View selected node only]

If selected, the [Specification tree] shows the result for only the selected node.

If [PVString0] is selected in the [Specification tree], the result table shows the data only for [PVString0].

Node	Month	Hour	Output Energy(kWh)	Input Energy(kWh)	Loss Energy(kWh)
CalcUnit0	1	1	0.00	0.00	0.00
PCS0	1	1	0.00	0.00	0.00
					102.00
					102.00
					102.00
				0.00	0.00
				0.00	0.00
PVString0	1	2	0.00		95.80

Verify the IV curve data

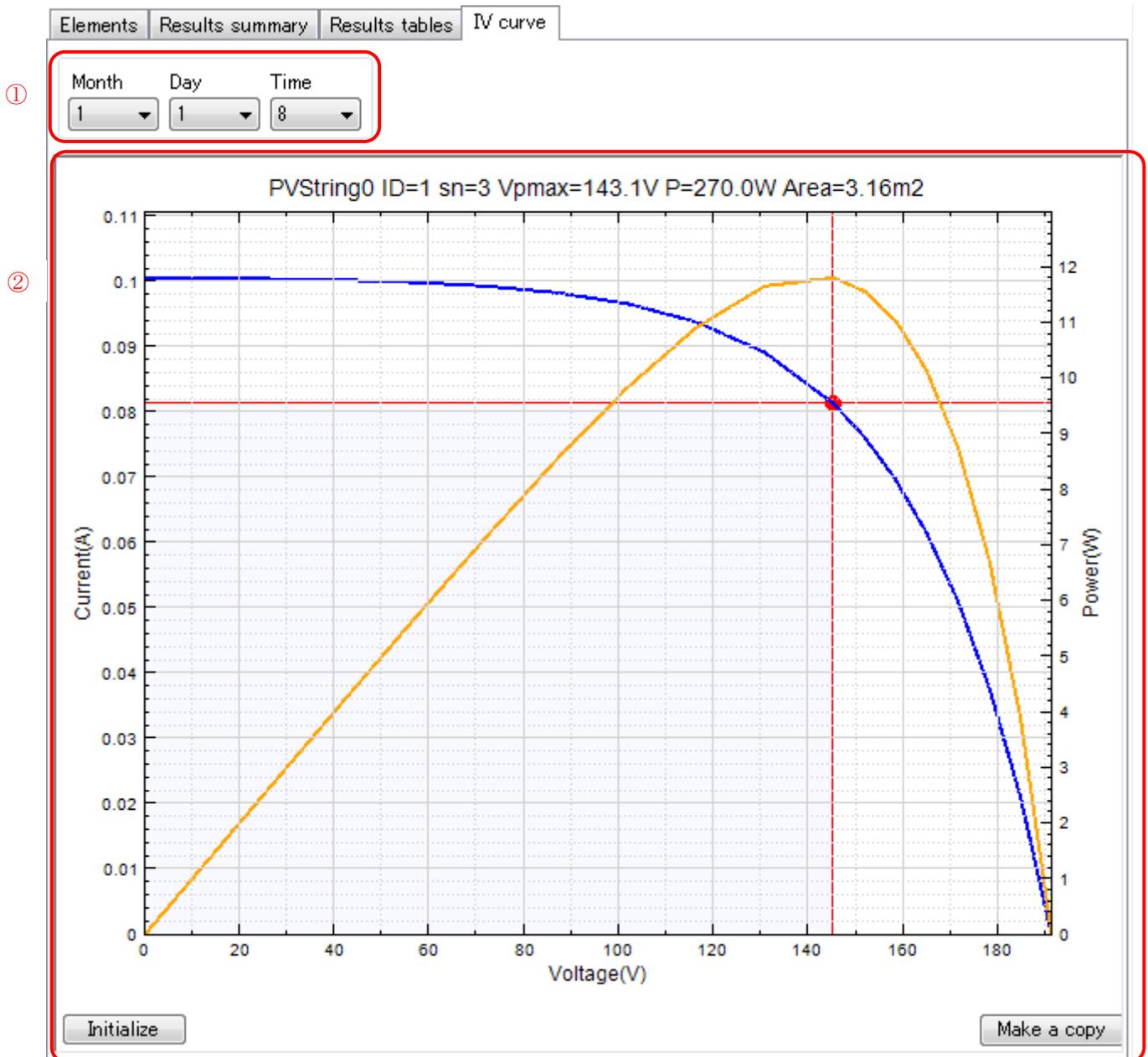
Verify the IV curve data of the PV string in each time period in the simulation.

If the calculation method is [PV module IV curve synthetic method], the modules and cell strings are shown in addition to the PV String nodes. Selecting a node in the tree

In [Specification tree], select the PV string under the calculation result node to verify and open the [IV curve] tab.

Select the PV string and open the tab.

The following table is shown.



The following data in the tabs and graphs are shown:

①...[Month], [Day], [Hour]

Select the time period to display the data.

②...IV curve graph

Shows the IV curve graph of the node selected in the specification string tree. The operating points in the specified time period for the specified node can be verified.